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ABSTRACT

Designed to help university and college faculty, academic administrators, and testing personnel select appropriate tests for college admission, this booklet provides a comparative description of the three physics examinations offered by the College Board. In separate sections, the following topics are covered: faculty involvement in test development; preparation for and uses of the Admissions Testing Program (ATP) Achievement Test in Physics, Advanced Placement (AP) B examination, and Advanced Placement (AP) C examination; abilities measured in the tests; differences and similarities among the tests; college student and AP candidate performance on the tests; and test data. Several charts of test data are included. (LP)

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THE PHYSICS EXAMINATIONS OF THE COLLEGE BOARD. 1980-1982

1980

College Entrance Examination Board
New York, New York

and

Educational Testing Service
Princeton, New Jersey

SE 041 785

The Physics Examinations of the College Board 1980-82

The College Board offers three examinations in physics:

- Admissions Testing Program (ATP) Achievement Test in Physics
- Advanced Placement (AP) Program Physics B Examination
- Advanced Placement Program Physics C Examination

All three of these examinations help postsecondary educational institutions respond to the varied backgrounds of entering students. The examinations provide a means of assessing skills and knowledge in physics so that students can be placed in appropriate courses or can receive recognition for proficiency equivalent to that gained through college courses. Certain subject matter examinations are available for local administration at colleges through Multiple Assessment Programs and Services (MAPS) of the College Board.

This booklet provides comparative descriptions of the examinations to help faculty members, academic administrators, and testing personnel in the selection of the tests that will best meet their requirements. It should also enable high school teachers of physics to guide students to a particular examination in terms of their preparation and needs, as well as the policies of their prospective colleges, which students should determine before taking an exam. The college or university determines not only which examination to use, but also the level of performance that an individual must demonstrate for admission, placement, or credit. The pamphlet *Guidelines on the Uses of College Board Test Scores and Related Data* provides specific advice.* Also, the College Board, through its regional offices, helps institutions develop policies and practices suited to their needs.

Faculty Involvement

Policy guidelines concerning the content and format of the examinations have been established by the Advisory Committee on Physics, which prepared this guide to the examinations and the recommendations for their use. Development Committees, often assisted by other consultants, write most of the questions that appear in experimental and final forms of the examinations. In addition to reviewing each other's questions by correspondence, committee members meet once or twice a year with test development specialists from Educational Testing Service (ETS) to make final revisions and selection of questions. An integral part of the meetings is the discussion of current content and statistical specifications. Also discussed are possible future changes in light of previous candidate performance, changing curriculums, and suggestions received from teachers. College and secondary school faculty members actively teaching physics comprise the membership of both Advisory and Development Committees in physics. The committees may sponsor regular open meetings in various parts of the country to which college and school faculty are invited or make periodic surveys of current practices and textbooks used. In addition, contact is maintained with the American Association of Physics Teachers, the National Science Teachers Association, and other professional organizations. A panel of college physics professors and secondary school AP Physics teachers grade the free-response (essay) questions of the AP Examinations in a central location. The free-response sections written by individual students are available to colleges and schools on request to ETS. Faculty involvement provides a critical link to the changing practices, curriculums, and standards of American physics education.

The Examinations

ATP Achievement Test in Physics

Assumed Preparation: The test covers the major topics usually included in one-year, high school physics courses. Because physics is most commonly taught in the senior year, many students take the Achievement Test before completing the course. They should be aware, therefore, that they may encounter topics that they have not yet studied. The test is appropriate for students who have used the most common high school physics textbooks, including those who have used the Physical Science Study Committee or Project Physics course materials.

*The Order Form on page 7 gives further information about *Guidelines* and other publications relating to the physics examinations of the College Board.

This booklet was prepared and produced for the College Board by Educational Testing Service.

The College Board and ETS are dedicated to the principle of equal opportunity, and their programs, services, and employment policies are guided by that principle.

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THE PHYSICS EXAMINATIONS OF THE COLLEGE BOARD

	Coverage	Format	Administration (When and Where Given)
ATP Achievement Test in Physics	One-year secondary school course in physics	60 minutes: 75 multiple-choice questions	Five times a year at ATP Test Centers
AP Physics B Examination	One-year introductory college survey course in physics not using calculus	90 minutes: 70 multiple-choice questions 90 minutes: 6-7 free-response questions	Annually in May in AP Participating Schools
AP Physics C Examination	First year of a one and one-half or two-year introductory sequence of college courses in physics using calculus	**Mechanics:** 45 minutes: 35 multiple-choice questions 45 minutes: 3 free-response sections **Electricity and Magnetism:** 45 minutes: 35 multiple-choice questions 45 minutes: 3 free-response questions	

NOTE: In addition to the three examinations listed, the College Board offers the College-Level Examination Program (CLEP) General Examination in Natural Sciences, which provides subscores in biological and physical science. The physical science subscore covers topics in chemistry, astronomy, and earth science in addition to physics. Only about one-third of the physical science questions deal with physics. The CLEP examination is appropriate for satisfying a distribution or general education requirement in the natural sciences. A more detailed description of the examination appears in *CLEP General and Subject Examinations.*

Possible Uses: The test is used as a selection instrument for admission to college and for placement of students in introductory physics courses that are appropriate to the students' demonstrated physics achievement. The test is not intended to be used for granting credit or exemption for most college physics courses.

AP Physics B Examination

Assumed Preparation: The Development Committee assumes that the candidates' preparation in physics is equivalent to a one-year college survey course treating all important topics (the type of course often taken by life science majors, premedical students, or other students who need some background in physics but who will probably not take additional physics courses). A knowledge of algebra and trigonometry and the ability to use them in the solution of physics problems is necessary. Many students do well on the examination on the basis of a high school physics course supplemented by independent study, but a formal AP Physics course is the most common means of preparation. Colleges do not normally require high school physics as a prerequisite for an introductory college physics course; high schools may also offer AP Physics as an intensive one-year course without a prerequisite physics course. For a more complete explanation, see the AP course description prepared by the Development Committee. Laboratory work is not tested directly in the examination, but laboratory experience is usually required in the analogous college courses and should be part of the candidates' preparation.

Possible Uses: The examination is designed for use in granting a full year of credit for a one-year college survey course or in granting exemption without credit. Advanced Placement grades, based on both the multiple-choice and free-response sections, are reported on a five-point scale: 5—extremely well qualified, 4—well qualified, 3—qualified, 2—possibly qualified, 1—no recommendation.

The examination is most likely to be appropriate for satisfying the physics requirement in programs such as life science or premedicine or for satisfying a general education requirement in science for liberal arts students. In many colleges, the Physics B Examination is not suitable as a prerequisite for advanced courses in physics.

Students planning to study medicine should investigate the curriculum at the college they plan to attend. Some colleges advise premedical students to take a course similar to the AP Physics C course rather than the Physics B course. These students should also be aware that the Physics B Examination, which is based

on the content of commonly taught non-calculus college physics survey courses, may not cover certain topics that are included in the physics part of the Medical College Admissions Test.

AP Physics C Examination

Assumed Preparation: The Development Committee assumes that the candidates' preparation in physics is equivalent to the first year of a typical one and one-half or two-year introductory sequence of physics courses that would normally be taken by majors in one of the physical sciences or engineering. The first term of the sequence is principally mechanics, and the second term is principally electricity and magnetism. A knowledge of elementary differential and integral calculus and the ability to use it as well as algebra and trigonometry in the solution of physics problems is necessary. Some students have scored well on the examination on the basis of a high school physics course supplemented by independent study, but a formal AP Physics course is the most common means of preparation. Colleges do not normally require high school physics as a prerequisite for a college physics course; high schools may also offer AP Physics as an intensive one-year course without a prerequisite physics course. For a more complete explanation, see the AP course description. Laboratory work is not tested directly in the examination, but some laboratory experience is usually required in the analogous college course and should be part of the candidates' preparation.

Possible Uses: The examination is designed for use in granting credit in college physics at the level described above. One part of the AP Physics C Examination covers mechanics; the other part covers electricity and magnetism. Students may take either part or both. Two grades are reported, one for mechanics, the other for electricity and magnetism. Each grade is reported on a five-point scale defined the same as for the AP Physics B Examination. To the extent that the first term in the college sequence is mechanics and the second term electricity and magnetism, the two examination grades may be used to grant credit for either or for both terms, to grant exemption without credit, or to place students in the appropriate level in their physics courses.

Abilities Tested

All the physics examinations are designed to test both knowledge of basic physics and the abilities to interpret and apply this knowledge both qualitatively and quantitatively. In recent editions of the Achievement Test in Physics, about 30 percent of the questions have been primarily recall questions. The rest of the questions require more complex thinking in combination with recall and usually involve the recall and use of one or more physical relationships in the solution of a problem.

In the AP Physics B and C Examinations, the percent of multiple-choice questions that are primarily recall is about 20 percent and 10 percent, respectively. The rest of the multiple-choice questions and most of the free-response questions generally require the recall and use of one or more physical relationships in the solution of a problem. These questions may ask students to:

- determine directions of vectors or paths of particles or light rays;
- draw or interpret diagrams;
- interpret or express physical relationships in graphical form;
- account for observed phenomena;
- explain steps taken to arrive at a result or to predict future behavior;
- manipulate equations that describe physical relationships; or
- solve problems that require the determination of numerical values.

In many of the free-response questions, students must carry out a sequence of such steps in arriving at the solution.

Differences among the Examinations

The AP Physics B Examination is similar in content to the Achievement Test in Physics but puts greater emphasis on modern physics and less on classical mechanics. (See the Content Specifications table.) The AP Physics B Examination as a whole tends to demand more analysis than does the Achievement Test in Physics. The multiple-choice questions on the former have a higher level of sophistication because of the difference in preparation assumed. Although there are fewer questions to be answered in a longer time than on the Achievement Test multiple-choice section, the problems require more time for reading and solution. The Development Committees determine, topic by topic, the appropriateness of the questions to the level of the tests.

Much less content overlap occurs between the Achievement Test and the AP Physics C Examination, and the preparation assumed for the examinations differs. Therefore, few questions would be appropriate for both examinations.

The AP Physics C Examination has greater depth, but less breadth than does the Physics B Examination. Because it is limited to two main topics, Physics C delves into them more deeply and with a greater analytical sophistication and covers subtopics which are treated briefly or not at all in Physics B. As Physics C requires greater mathematical background, both of its sections are more quantitative and analytical than those of Physics B. However, some questions are common to both examinations.

Numerical computation is not stressed in any of the examinations. Slide rules and electronic calculators are allowed for the AP Physics B and C Examinations but not for the Achievement Test in Physics.

CONTENT SPECIFICATIONS
(by approximate percent of test)

	ATP Achievement Test in Physics	AP Physics B Examination	AP Physics C Examination
Classical Mechanics	40%	33%	50%
Electricity and Magnetism	20%	25%	50%
Optics and Waves	20%	15%	
Heat and Kinetic Theory	10%	7%	
Modern Physics (atomic, nuclear, quantum concepts, special relativity)	10%	20%	
	100%	100%	100%

Note: For further details about the content of the three examinations, consult *About the Achievement Tests* and the Advanced Placement course description for Physics B and Physics C.

Comparison of the AP Physics B Examination and the ATP Achievement Test in Physics

Because the content specifications of these two examinations are similar and because the Advisory Committee judged a large number of questions in the Achievement Test to be appropriate for the Physics B Examination, a study compared the ability of 2,112 students taking the Achievement Test in Physics in November 1974 and 1,213 students taking the Physics B Examination in May 1976. The examination forms taken by these examinees had 20 multiple-choice questions in common. Thus, equivalent scores on both examinations could be estimated.

The mean scores and standard deviations for the two groups of students on the 200-to-800 scale on which the Achievement Test scores are reported were as follows:

	November 1974 ATP Achievement Test in Physics Examinees (Actual Values)	May 1976 AP Physics B Candidates (Estimated Values)
Mean Score	611	657
Standard Deviation	98	84

The mean score of all the Achievement Test in Physics examinees in 1976-77 was 593. The November 1974 examinees obviously were a somewhat more able group.

On the Physics B reported scale of 1 to 5, the 1976 AP candidates averaged 2.9. On this same scale, the November 1974 Achievement Test examinees would have averaged about 2.4 and the 1976-77 examinees about 2.2. The reported grade on the Physics B Examination was related to the 200-to-800 scale on which the Achievement Test scores are reported, resulting in the approximate equivalencies shown in the next column:

November 1974 ATP Achievement Test in Physics Examinees		May 1976 AP Physics B Candidates	
Estimated Equivalent Scaled Score Range for Corresponding AP Grade	Percent of Examinees Earning Score in Range	Reported AP Grade	Percent of Candidates Earning Grade
760-800	6%	5	12%
694-754	17%	4	21%
621-688	24%	3	33%
591-615	15%	2	14%
475-584	37%	1	20%

The results of this comparison show that although the AP Physics B candidates scored significantly higher as a group on common questions, there was considerable overlap in ability. About 23 percent of the November 1974 Achievement Test in Physics examinees scored at a level high enough to have expected a grade of 4 or 5 in the AP Physics B Examination. About 19 to 20 percent of the 1976-77 Achievement Test in Physics examinees scored at this level.

Comparison of College Students and AP Candidates on the Multiple-Choice Sections of the Physics C Examination

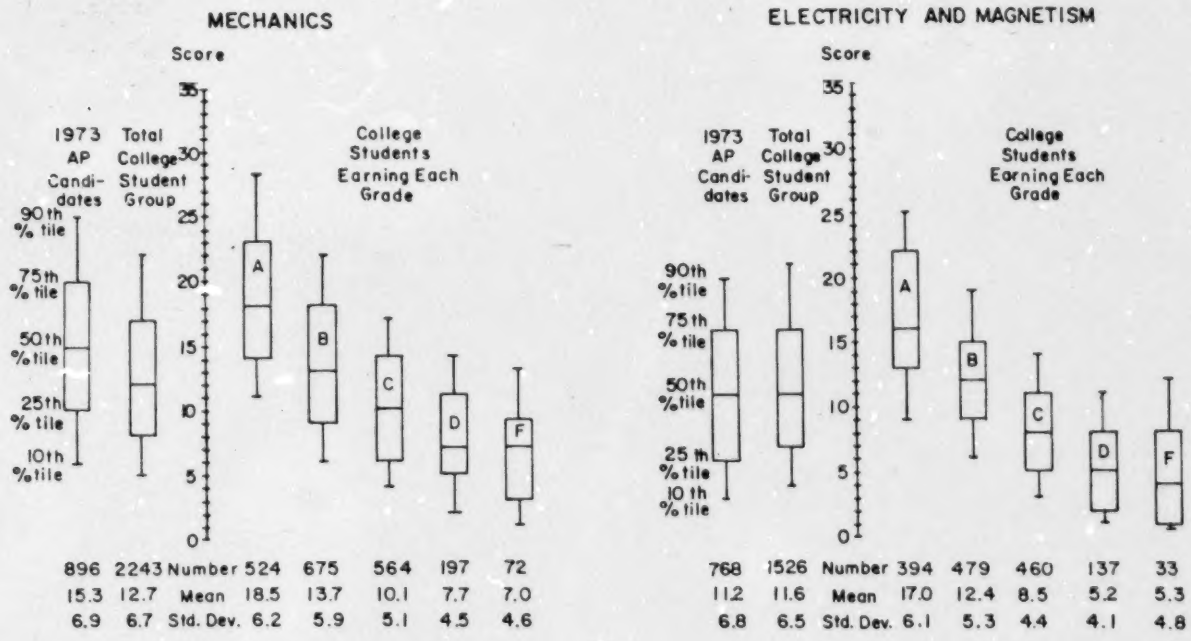
In 1974-75, the multiple-choice sections of both parts of the 1973 AP Physics C Examination were given as parts of final examinations to college students completing the appropriate semester of an introductory calculus-based physics course. Almost 3,800 students were tested in 15 colleges which are among those receiving the largest number of AP candidates. Grades earned in their physics courses were obtained for most of the college students. Data for the 1973 AP Physics C candidates and for the college students on these examinations are given in the figure on page 5. The multiple-choice score equivalents corresponding to the 10th,

25th, 50th, 75th, and 90th percentiles are given in addition to the sample sizes, means, and standard deviations for the AP candidates, for the total college student group, and for the college students who received each grade from A to F. The scores on the 35-question multiple-choice sections were obtained by subtracting one-fourth of the number of incorrect answers from the number of correct answers indicated by the students. As a group, the AP candidates scored significantly higher than the college students in mechanics but about the same in electricity and magnetism. This is a reasonable result, as the poorest college physics students in the first term (which is primarily mechanics) do not usually go on to take the second term (which is primarily electricity and magnetism). Also, the number of colleges in the electricity and magnetism sample was smaller and included a higher proportion of more highly selective colleges than in the mechanics sample.

Although 53 to 59 percent of the college students received As and Bs in their college physics courses, only 36 percent of the AP Mechanics candidates and 29 percent of the AP Electricity and Magnetism candidates received 4s or 5s. Since the study was done, the percentage of 4s and 5s received by Physics C candidates has gradually increased to about 50 percent for both parts to bring the grades more into line with those in the colleges.

The details of this study have been reported in the November 1977 issue of the *American Journal of Physics*.

COMPARISON OF COLLEGE STUDENTS AND AP CANDIDATES ON THE MULTIPLE-CHOICE SECTIONS OF THE PHYSICS C EXAMINATION



Comparative Test Data

The table below provides the measurement characteristics (score scale, mean, standard deviation, reliability, standard error of measurement, and percent completing 75 percent of test) of the examinations.

COMPARATIVE TEST DATA

The figures are for the most recent form of the test analyzed at the date of this publication.	Score Scale	Mean	Standard Deviation	Reliability	Standard Error of Measurement	% Completing 75% of Test
ATP Achievement Test in Physics	200-800	571	103	.91	29	98.2
AP Physics B Examination						
Multiple-choice	—	—	—	.90	—	99.7
Free-response	—	—	—	.75-.85	—	—
Composite	1-5	3.0	1.3	.90-.93	9.6-11.3[a]	—
AP Physics C Examination						
Mechanics						
Multiple-choice	—	—	—	.85	—	94.6
Free-response	—	—	—	.70-.80	—	—
Composite	1-5	3.4	1.3	.87-.90	6.0-6.9[b]	—
Electricity and Magnetism						
Multiple-choice	—	—	—	.85	—	99.4
Free-response	—	—	—	.75-.85	—	—
Composite	1-5	3.4	1.3	.89-.91	5.3-6.1[c]	

Note: The score on all multiple-choice sections of these tests is corrected for guessing by subtracting from the number of correct questions one-fourth of the number of questions marked wrong.

[a]For composite raw scores on an edition of the test with a maximum possible composite score of 210, mean of 83.29, and standard deviation of 35.82

[b]For composite raw scores on an edition of the test with a maximum possible composite score of 90, mean of 42.02, and standard deviation of 19.03

[c]For composite raw scores on an edition of the test with a maximum possible composite score of 90, mean of 38.35, and standard deviation of 17.93

Glossary

Mean: The average

Reliability: The consistency of the grade or score that candidates would receive if they were to repeat the examination (usually expressed as a correlation coefficient)

Scaled Score: A score to which a raw score is converted for reasons of convenience, comparability, and ease of interpretation

Standard Deviation: A measure of the spread (extent of variability) of a set of scores around their mean. The less the spread, the smaller the standard deviation

Standard Error of Measurement: An indication of the extent of the error inherent in an obtained score because of the imperfect reliability of a test. It indicates (in score units of the test) the range of discrepancy between the true score and the obtained score.

True Score: The score a student would earn if a test could measure ability perfectly

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NOTE: Requests for information about the use of a program should be directed to your College Board Regional Office. Specific questions about any of the physics examinations may be addressed to the ETS consultant listed above, Educational Testing Service, Princeton, New Jersey 08541.

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